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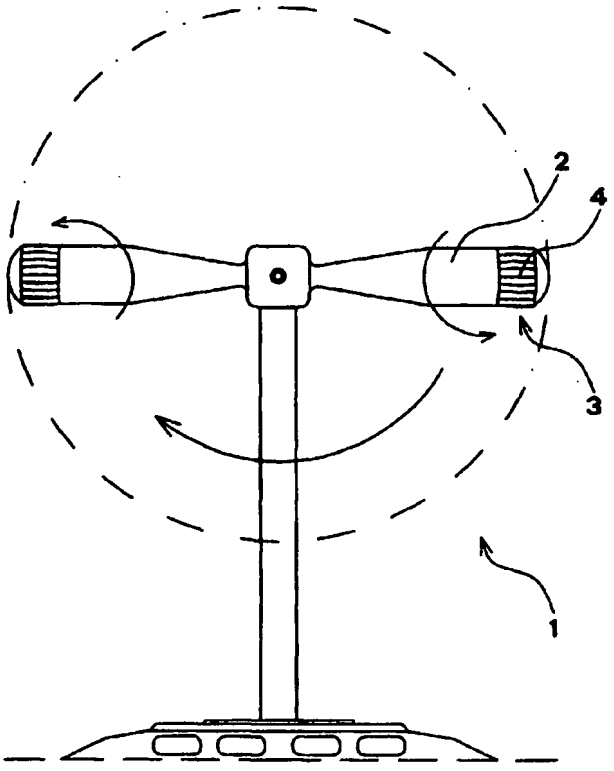
(54) Title: WIND GENERATOR USING MAGNUS-EFFECTS




(57) Abstract: The invention concerns a wind generator to obtain mechanical energy, and particularly also its use for the propulsion of naval means, characterised in that it provides at least two blades (2), rotating about a rotation axis perpendicular to their own axis, and provided also of rotation about their own axis, each one of said blades (2) providing, on a substantially distal part (3), a plurality of projecting fins (4), said fins having suitable profile and inclination in function of the specific use.

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# WIND GENERATOR USING MAGNUS-EFFECTS

The present invention relates to a wind generator with blades having ends with modified profile, for the production of energy, and its use for naval means having improved hydrodynamic features, and nautical vehicle employing said wind generator.

More specifically, the invention concerns a wind generator with blades with modified profile at their end for the production of energy, able to transform kinetic energy taken from the fluid stream into energy within a speed range of the real wind even very low and to sustain the same for a unlimited time period, i.e. an operative machine with high efficiency, even within the wind speed range from 1.5 – 2 m/s to 4 – 5 m/s, where present wind generators are not activated, or where efficiency is very low.

It is well known to every body that the present growing trend of the oil costs, and expectations about the duration of this source, to produce energy, make always more interesting the search of alternative sources.

It is also known that, among them, the one on which the attention of the researchers is focused, also in view of its better efficiency, is the wind one.

Main object of the present invention is that of providing a solution allowing an optimum exploitation of the wind energy, i.e. an energy source not sufficiently exploited as yet.

Commitments undertaken by the Kyoto Protocol provide a 6.5% reduction of the greenhouse emission into the atmosphere, imposing to rely on the development of the renewable sources. Doubling of the production of energy from renewable source would give a contribute of 25 – 20%.

For example, in Italy, at present, renewable sources give a contribution of about 12.73 million of oil equivalent tons (Mtep), corresponding to 7.37% of the national energetic needing.

Among the clean alternative energies, production of electric power by windmill has reached technical features sufficiently modern, for a better diffusion.

In view of the above, the Applicant has specifically studied a solution to realise a wind generator with blades (having a cylindrical – conical shape) with a modified profile for the production of energy, said blades having the profile modified in correspondence of their end portion, for the production of energy and for the use of the wind generator to naval means having an advanced hydrodynamic profile.

Particularly, according to the invention, it is suggested a solution that, with respect to the known solutions, allows to obtain a valuable amount of energy even with weak real wind (1.5 : 5 m/s; 3 – 10 knots), with a large exploitation of the energy produced for the generation of a thrust about 6 – 18 times bigger than that obtained by the present windmill, or to the thrust of the present modern sails.

Another object of the present invention is that of providing a technical solution which allows to lower production costs for the wind generator according to the invention.

The solution according to the present invention is based on the technical principle that energy is generated by a generator placed into the wind flow, and transmitted in various ways, that are not the object of the present invention, to a propeller or other suitable propulsion member, basing on the exploitation of the Magnus effect.

Principles that are the basis of the Magnus effect are experimentally known since 1852, are well known to those skilled in the art, and thus it is deemed not necessary to describe them in greater detail.

Summarising, Magnus effect is based on the fact that a cylindrical body orthogonally immersed within an uniform fluid stream, rotated about its own axis, is subjected to an bearing action perpendicular to the direction of the stream speed vector. In the same way, a fixed cylinder rotating about its own axis within a wind coming from a transverse direction is stressed by a lift.

Lift dependency from the square ray of the cylindrical section is relevant for the performances of the physical system.

It is therefore specific object of the present invention a wind generator to obtain mechanical energy, and particularly also its use for the propulsion of naval means, characterised in that it provides at least two blades (having a particular cylindrical – conical shape with a profile modified in correspondence of their end), rotating about a rotation axis perpendicular to their own axis, and provided also of rotation about their

own axis, each one of said (cylindrical) blades providing, on a substantially distal part, a plurality of projecting fins, said fins having suitable profile and inclination in function of the specific use.

According to the invention, said part of each blade (having a particular cylindrical – conical shape with a profile modified in correspondence of their end) (cylindrical, rotating) with said plurality of fins, can be realised integrally with the same blade (having a particular cylindrical – conical shape with a profile modified in correspondence of their end), or it can be separated with respect to the same blade, in the latter case being able to rotate independently and/or integrally with said blade (having a particular cylindrical – conical shape with a profile modified in correspondence of their end).

Particularly, according to the invention, said part of the blade (having a particular cylindrical – conical shape with a profile modified in correspondence of their end) with said plurality of fins provides coupling means that, when the motion with respect to the blade (having a particular cylindrical – conical shape with a profile modified in correspondence of their end) exceed a pre-established value, making the same part integral with the blade (having a particular cylindrical – conical shape with a profile modified in correspondence of their end), making them integrally rotating about the axis of the blade (having a particular cylindrical – conical shape with a profile modified in correspondence of their end).

Preferably, according to the invention, said coupling means can be comprised of a series of spikes shaped sectors, provided on said part of the blade (having a particular cylindrical – conical shape with a profile modified in correspondence of their end) with the plurality of fins, maintained in a crown configuration by the tension of suitable elastic supports, expanding and engaging in the blade profile (having a particular cylindrical – conical shape with a profile modified in correspondence of their end) when the apparent force exceeds a pre-established value.

Always according to the invention, said blade (having a particular cylindrical – conical shape with a profile modified in correspondence of their end) preferably provides a hub tapered profile, choosing among those that will be determined to be the most efficient after tests within the wind gallery.

Furthermore, according to the invention, said plurality of fins can be adjustable, modifying their orientation in function of the specific use.

Further, according to the invention, said fins can provide a distal projection, eventually adjustable independently from the same fins.

According to the invention, said wind generator can provide three, four, or a higher number of blades.

The invention further concerns a nautical means providing a wind generator according to the invention, the energy produced by said generator being directly or indirectly exploited.

The present invention will be now described, for illustrative but not limitative purposes, according to its preferred embodiments, with particular reference to the figures of the enclosed drawings, wherein:

figure 1 is a schematic view of a first embodiment of a wind generator according to the invention;

figure 2 is a schematic view of a second embodiment of a wind generator according to the invention;

figure 3 is a schematic view of a third embodiment of a wind generator according to the invention;

figure 4 is a first perspective view of a first embodiment of a part of a blade, particularly of the vertical fins and of the horizontal fins (for cutting the flow) of a wind generator according to the invention;

figure 5 is a second perspective view of a first embodiment of a part of a blade (having a particular cylindrical – conical shape with a profile modified in correspondence of their end) (cylindrical – conical) of a generator according to the invention;

figure 6 is a first perspective view of a second embodiment of a part of a blade (having a particular cylindrical – conical shape with a profile modified in correspondence of their end) (with a shape of the cylindrical – conical type) of a wind generator according to the invention;

figure 7 is a second perspective view of a second embodiment of a part of a blade (having a particular cylindrical – conical shape with a profile modified in correspondence of their end) of a wind generator according to the invention;

figure 8 is a top view of the blade part (having a particular cylindrical – conical shape with a profile modified in correspondence of their end) of figure 6 and 7; and

figures 9a, 9b, 9c and 9d are lateral, front, perspective and top views, respectively, of a possible use of the wind generator according to the invention on a nautical means.

In figures 1, 2 and 3, different embodiments of the wind generator according to the invention are shown, all based on the same functional principle, being different each other only for the number of blades provided.

Referring to all figures 1 – 3, as well as to figures 4 – 8, it can be noted that blade 2 (having a particular cylindrical – conical shape with a profile modified in correspondence of their end) of the wind generator 1 according to the invention has a cylindrical – conical shape, with a more or less large part 3, according to the specific needings, provided with fins 6, the structure of which is shown, for illustrative, but not limitative purposes, in figures 4 – 8.

Part 2 of the wind generator 1, provided with fins 4, can be integrally obtained from the blade 2 (having a particular cylindrical – conical shape with a profile modified in correspondence of their end), or it can be a part 3 separated from the blade 2 (having a particular cylindrical – conical shape with a profile modified in correspondence of their end).

In this case, as it will be described in greater detail in the following, continuity of the blade 2 (having a particular cylindrical – conical shape with a profile modified in correspondence of their end), is obtained by the dynamic condition reached during its operation.

Particularly, solutions are shown in the figures (part 3 separated from the blade 2 (having a particular cylindrical – conical shape with a profile modified in correspondence of their end). At first, part 3 of the blade 2 (having a particular cylindrical – conical shape with a profile modified in correspondence of their end), on the section of which the micro-fins 4 are realised, is rotated about the blade 2 axis, by the wind effect, the real speed of which is directed perpendicular to the plane of the wind generator 1, and angled with respect to the micro-fins 4.

A Magnus effect will be obtained on the part 3 of the blade 2, since air flow is cut and consequently a bearing force is generated, perpendicular to the blade 2 axis, and lying in the wind generator 1 plane.

Value of the generated bearing force is bound to the real speed wind, lower to the value necessary to rotate the whole blade 2 about its own axis.

With a suitable value of the rotation speed, rotating part 3 will couple, by well known means, to the other part of the blade 2, rotating the same according to rigid body dynamic laws, and the Magnus effect will create a lift on the whole blade 2, that must be multiplied for the number of blades 2 provided in the wind generator 1.

In the solutions shown in the figures, blade 2 has a part of the blade 2, comprising also the end portion of the blade, having a particular spherical – cylindrical section with a suitable relief to cut the threads.

To obtain the rotation of the blade 2, when a determined speed has been reached by the part 3, having the micro-fins 4, said part 2 has a series of spike shaped sectors (not shown) hinged to the same, placed according to a crown configuration by the tension of suitable elastic supports (not shown as well).

When the apparent force of the relative motion (centrifugal force) passes a tension value of the elastic supports, sectors expands and engage with the profile, within the seats obtained on the first element.

In this way, part 2 of the blade is rotated and, on the basis of the dynamic laws, angular speed will diminish proportionally to the ratio of the rotating masses, and will obviously increase the cut flow, since the rotating cylinder will be longer.

The described and shown blade 2 solution is advantageous since it can operate the wind generator 1 exploiting the spin due to a limited part 3 of the blade 2, and thus with reduced masses involved. It is particularly suitable for large rotors having large inertia forces.

As already said, even if it is not illustrated in the figures, blade 2 can also be comprised of a single element, i.e. with the part 3 integral with the same blade 2 (having a particular cylindrical – conical shape with a profile modified in correspondence of their end). Said blade 2 idly rotates about an axis pivoted on the hub.

For this solution too, due to the shape of the blade 2 (having a particular cylindrical – conical shape with a profile modified in correspondence of their end) and to the position of the fins 4, the same consideration set forth for the blade 2 comprised of two separated parts 2, 3 apply.

In this case, extension of fin depends on the aerodynamic calculation and on the inertia opposed to the whole blade 2, since the starting spin effect does not exist.

Integral blade 2 is advantageous when the rotation structures are small for enslaved energy generators, for example little hulls, or in any case are comprised of material allowing a high efficiency/weight ratio.

Instead, two part blade 2, with its particular engagement method, has an application field where rotating areas are large, and thus the structures are proportionally heavy. In this case, inertia forces to be overcome to rotate the structure would be too high.

As it can be seen from figures 4 – 8, micro-fins 4 can be oriented according to the wind intensity, more or less angled, having a more or less thin profile, a more or less large surface, in a higher or smaller number, and/or with the possibility of translating radially with respect to the blade axis, realising a bigger passage section for the flow, and an increase of the torque due to the lengthening of the support profile.

Further, in figures 6 – 8, a further projection 5 on the micro-fins 4 is shown, said projection being eventually adjustable.

In figures 9a – 9d, an application of the wind generator according to the invention on a nautical means is shown.

It must be noted that the kind of the nautical means 6 cannot be in any way considered limitative of the present invention, as well as it must not be considered limitative the number of blades provided in the wind generator 1 mounted on the nautical means 6, said choices obviously varying in function of the specific case.

The application of the wind generator according to the invention to a nautical means can validly be proposed in the maritime navigation conditions, where the cylindrical wing profile.

In fact, wind generator 1 according to the invention has been suitably studied to obtain at the same time a high sailing solidity, a high pressure coefficient for all the dynamic conditions, a good peripheral speed and consequently a good apparent wind.

Wind generator 1 according to the invention can be active with a real wind speed of 1.5 m/s (3 knots), at the same time acquiring an apparent wind not lower than 3 – 4 m/s, and consequently a good lift and power on the axis wit a modest spin energetic expense.

Taking into consideration that the present technologies allow a very wide control of the spin rotation of the rotating blades, a machine able to obtain the maximum lift with every meteorologic condition is obtained, even under extreme conditions.

This variability of the rotation, along with the rotation about its own axis, with a stabilisation by the lee side central structure or with a self-directional, wing profiled carrier mast, having a low resistant coefficient and high aerodynamic penetration, allows a use of the wind generator according to the invention with the minimum wind conditions, conditions in presence of which every wind generator or modern sailing boat would be almost still, or with so low results to be necessary to operate the engine propulsion.

Making a comparison with a geometrical parameter, for example the diameter, it is put into evidence that said machine having a total diameter of the blades of about 16 meters and 220 $m^2$ of surface can be compared with a traditional wing profile machine with 4400 $m^2$ and a diameter of 80 m.

Said projection does not substantially differ from the one that can be verified with the wind physical principles between an equal traditional sail surface and the wind generator of the motor ships measured within the wind gallery.

For exemplificative purposes, some features are provided that should have a nautical means 6 for the better exploitation of the wind generator 1 according to the invention.

Particularly, nautical means 6 should preferably:

- Be of the gliding kind, but without evident limitations of the opera viva to allow an optimum hydrodynamic scivolamento within the water and at the same time a high seaworthiness;
- Allow a high loading of the boat without jeopardising the speed and seaworthiness features;
- Enjoy of stabilising fins and for the abeam motion (with suitable wing – profile, low draft, bayonet derive;
- Have horizontal stabilising fins to help and limit the displacements of the wave motion in function of the loading and velocity (as it occurs with the standard flaps of the new engine boats, controlling their attitude and buoyancy, decreasing with the increasing of the speed , thus allowing to subsequently increase the speed);
- Not have the keel constituting a redressing moment and consequent corresponding to a boat long 10 m and lighter of

1500 kg (corresponding to 35% less of weight, corresponding to the loading capability of the boat);

- Be provided with energy storage batteries, when the sail propulsion is disconnected from the propeller axis. Their power is of 120 A. 6 batteries are, for example, able to make possible the manoeuvring within the harbour by electrical engines, like those available on the market and employed for the bow propellers in the large boats. Weight is distributed at the bottom and at the centre of the boat, making an optimum redressing moment. Weight is of about 180 kg;
- Be provided with photovoltaic panels of the Solax type, each providing 30 Watt x 12 hours, satisfying the board use and all the instruments, the radio, GPS, etc.;
- Have foldable lateral wings of the hull (compass or hydraulic bayonet kind for large boats), or telescopic wings, to allow the reduction of the dimensions before the mooring, thus facilitating the manoeuvre, even maintaining the buoyancy. They can be used to stow light objects;
- Have the j-prop type propeller, with suitable dimensions (about 1.5 times bigger than those usually employed), having variable step, allowing the hull speed control and the power modulation in also function of the load and of the sea conditions;
- Employ a hydraulic s-drive transmission, allowing an optimum transmission efficiency without maintenance;
- Have bow sections such to guarantee the maximum buoyancy length and at the same time a suitable wave cutting in case of rough sea;
- Have clearly little rudder sections similar to an intermediate solution between the regatta elliptical rudder and the modern motor ships with high aspect radio appendixes, allowing reduced hydrodynamic resistances and maintaining high lift when manoeuvring;
- Have a structure very similar to the structure of these trimarans and the sail propulsion seat in the centre of the boat with respect to the traditional hulls, also to obtain a

central weight to allow a stabile upwind pace, without lifting too much the bow, in such a way to splinter the swell maintaining a constant attitude, allowing to reach a high speed with optimum fresh way maintenance.

Finally, some economical considerations will be given with respect to the realisation and the utilisation of a wind generator according to the present invention.

At present, to realise a wind central station, the cost is of 2 millions of liras per KW, varying between 1.57 and 1.83 M/Itl.

It should be taken into consideration that a reduction of the production cost will be obtained with the increasing of the number of these machines produced, even in function of their dimensions. In fact, in Germany the costs passed from 2,4 MilLit/KW for 150 KW machines to 1,8 M/Itl for 300 KW machines, up to 1.7 MilLit(KW for 600 KX machines.

Optimising the efficiency of the wind generator 1 according to the invention, said costs, in view of its efficiency features at least 6 – 7 times higher than a generator having the same dimensions, will be very interesting.

In fact, while at present the wind systems, to be exploited, must be placed in zones where the minimum windiness is not lower to 4 m/s and for at least 100 days per year, in the future, by the use of the wind generator according to the invention, application zones will be remarkably wider, also for the particular starting conditions with 1.5 – 2 m/s.

The present invention has been described for illustrative but not limitative purposes, according to its preferred embodiments, but it is to be understood that modifications and/or changes can be introduced by those skilled in the art without departing from the relevant scope as defined in the enclosed claims.

# CLAIMS

1. Wind generator to obtain mechanical energy, and particularly also its use for the propulsion of naval means, characterised in that it provides at least two blades, rotating about a rotation axis perpendicular to their own axis, and provided also of rotation about their own axis, each one of said blades providing, on a substantially distal part, a plurality of projecting fins, said fins having suitable profile and inclination in function of the specific use.

2. Wind generator according to claim 1, characterised in that said part of each blade (having a particular cylindrical – conical shape with a profile modified in correspondence of their end) with said plurality of fins, is realised integrally with the same blade.

3. Wind generator according to claim 1, characterised in that said part of each blade (having a particular cylindrical – conical shape with a profile modified in correspondence of their end) with said plurality of fins, is realised separated with respect to the same blade, in this case being able to rotate independently and/or integrally with said blade.

4. Wind generator according to one of the preceding claims, characterised in that said part of the blade (having a particular cylindrical – conical shape with a profile modified in correspondence of their end) with said plurality of fins provides coupling means that, when the motion with respect to the blade exceed a pre-established value, making the same part integral with the blade, making them integrally rotating about the axis of the blade.

5. Wind generator according to one of the preceding claims, characterised in that said coupling means are comprised of a series of spike shaped sectors, provided on said part of the blade with the plurality of fins, maintained in a crown configuration by the tension of suitable elastic supports, expanding and engaging in the blade profile when the apparent force exceeds a pre-established value.

6. Wind generator according to one of the preceding claims, characterised in that said blade provides a hub tapered profile, choosing among those that will be determined to be the most efficient after tests within the wind gallery.

7. Wind generator according to one of the preceding claims, characterised in that said plurality of fins are adjustable, modifying their orientation in function of the specific use.

8. Wind generator according to one of the preceding claims, characterised in that said fins provide a distal projection, eventually adjustable independently from the same fins.

9. Wind generator according to one of the preceding claims, characterised in that said wind generator provides three, four, or a higher number of blades.

10. Nautical means characterised in that it provides a wind generator according to one of the preceding claims 1 – 9, the energy produced by said generator being directly or indirectly exploited.

11. Wind generator to obtain mechanical energy, and particularly also its use for the propulsion of naval means, according to each one of the preceding claims, substantially as illustrated and described.

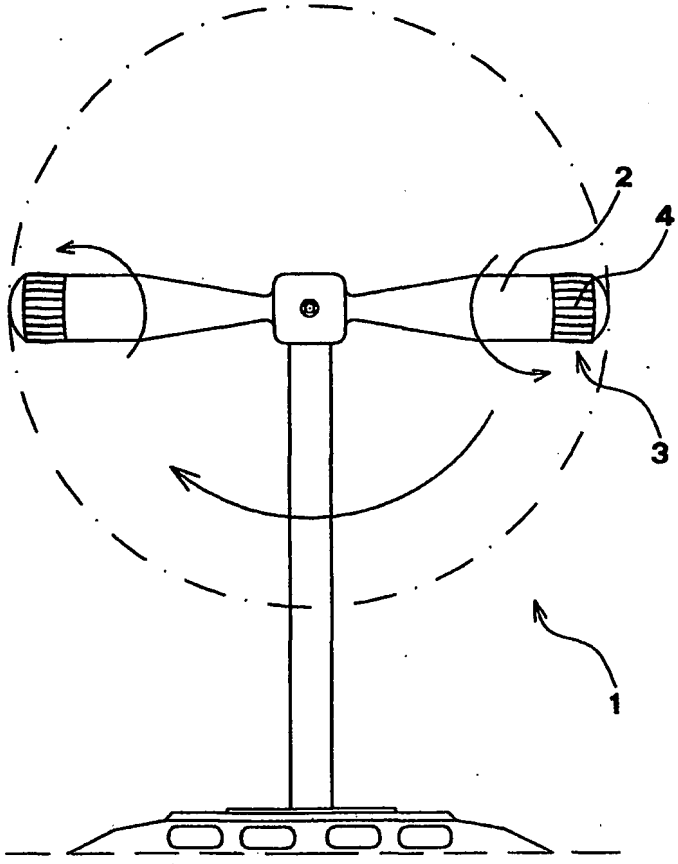


Fig. 1

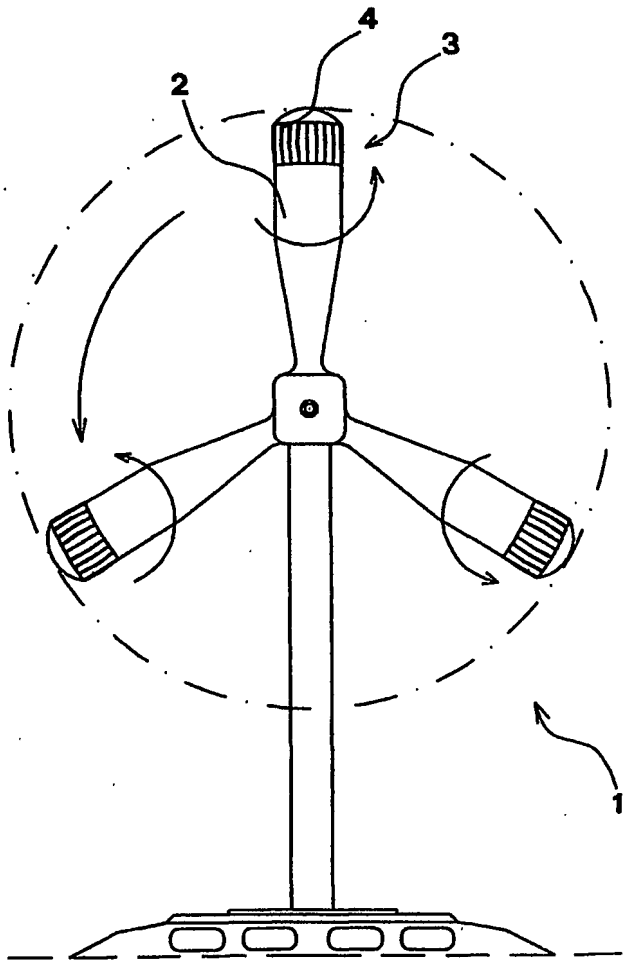


Fig. 2

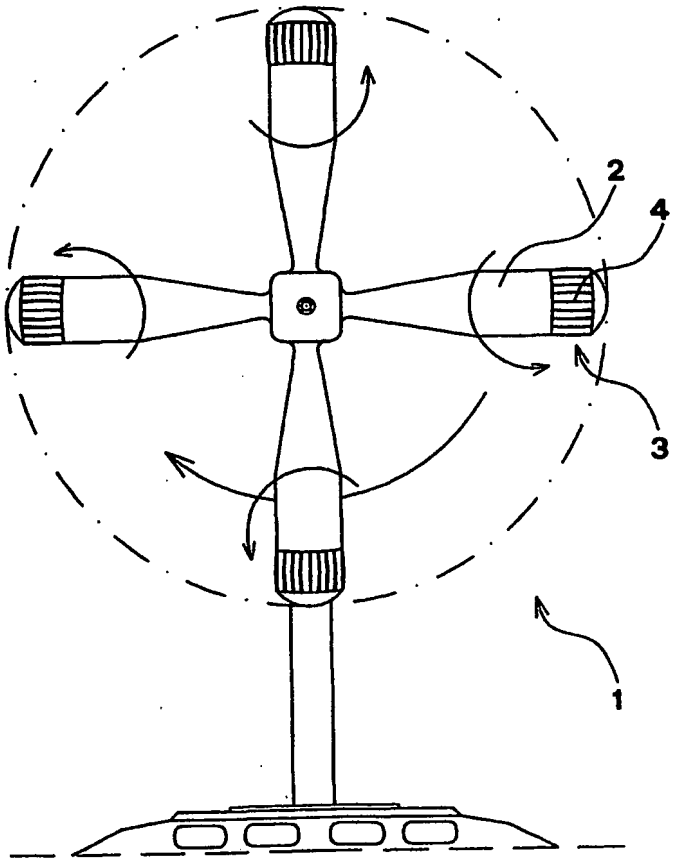


Fig. 3

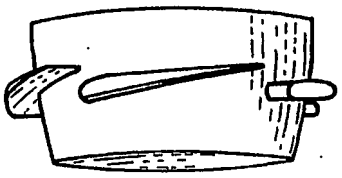

Fig. 4

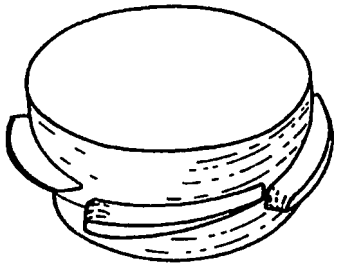

Fig. 5

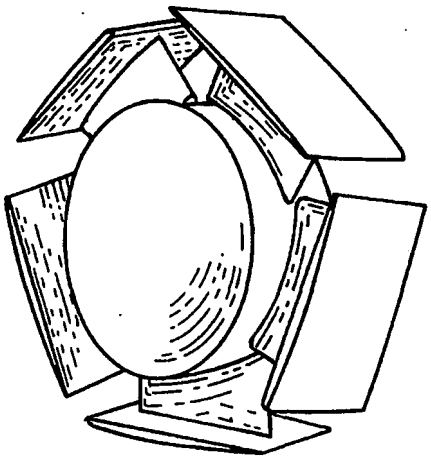

Fig. 6

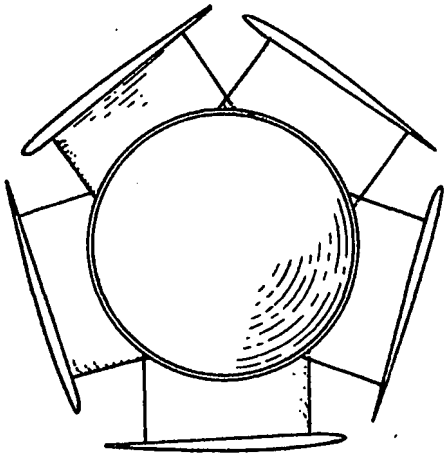

Fig. 7

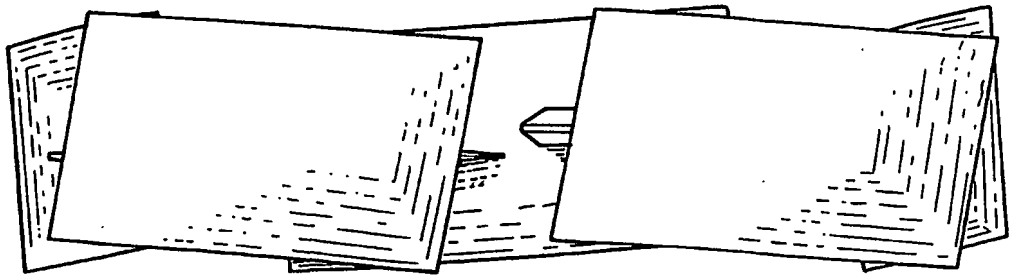

Fig. 8

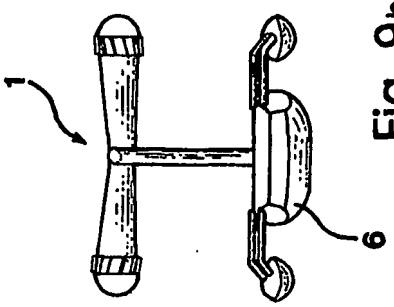


Fig. 9b

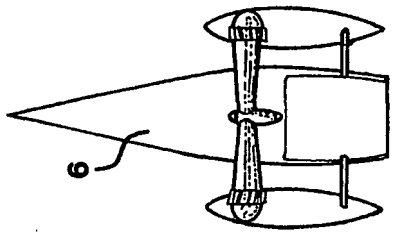


Fig. 9d

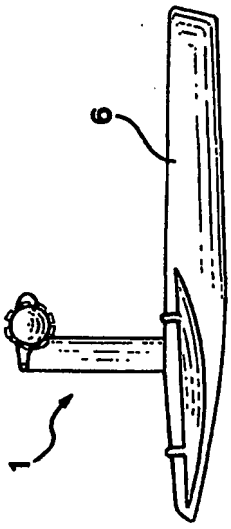


Fig. 9a

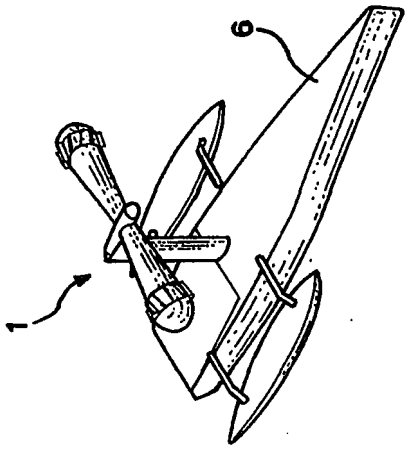


Fig. 9c

# INTERNATIONAL SEARCH REPORT

Inter al Application No
PCT/IT 01/00570

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F03D1/06 F03D11/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F03D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br>Y | DE 32 46 694 A (KREBS ERICH DIPL ING)<br>20 June 1984 (1984-06-20)<br>page 11, line 9 -page 12, line 10; figures 4,5 | 1,2,7,9,<br>11<br>2,10 |
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[X] Further documents are listed in the continuation of box C.

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| European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Angelucci, S |

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